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An investigation of behavioural and structural characteristics of CEP service providers and freight demand considering e-commerce in Germany

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Abstract

With the advent of the Internet in private households and in almost every company in the last two decades, many things have changed. One of the major changes concerns the rapid growth of the e-commerce utilization, which brings changes to the transportation system – e.g., courier, express and parcel service providers (CEP) sector with it. Thus, the CEP sector is the most increasing and dominant logistics sector worldwide. Especially in agglomerations, a high growth potential is expected for the future. It is mostly driven by the demand of private households and retail in urban agglomerations. Considering the importance of CEP, the knowledge about CEP – from a transport modeller's view – is still scarce. There are several studies with focus on consumer's e-commerce behaviour or the supply side. However, – as far as the authors are aware of – there are no extensive studies examining both, transport demand and supply. This, however, is crucial for a better understanding and modelling of CEP actors. We present our first results and a theoretical and empirical based approach to characterise not only the supply side of CEP service providers, but also the demand side of private households, and businesses regarding e-commerce as a driver for the development of freight demand.

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Keywords: CEP service providers; freight demand; e-commerce; secondary data analysis; freight transport demand modelling

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1. Introduction

A significant growth in population has been observed in cities worldwide since 1950. In 2050, almost 70% of the world's population will live in urban agglomerations (OECD 2012). The demand pressure on the transport infrastructure and traffic contributions of freight transport rises with the size of a metropolitan area. Thereby, the key emerging trends are the increased use of e-commerce by private households and the replacement of storage in the industrial and retail through flexible and small-scale delivery of goods. Furthermore, the increasingly smaller parcels show another trend in freight transport in the CEP sector. In 2013, the total revenue made in the German parcel segment was about 8.0 bn. €. Thereby, 2.7 bn. shipments were sent. That shows an increase of 57% of shipment volumes compared to the year 2000 for the German CEP sector. Studies show that the companies expect further growth in shipment volumes from 2013. They expect a growth by an average of 4.3% each year and more than 3.3 bn. shipments by 2018 (Esser and Kurte 2014). The result of the rapid growth in shipment volumes is a significant increase in trips of small and medium sized trucks especially in the CEP sector. The CEP trucks have a relatively small proportion of total urban transport. However, they have disproportionally high negative impacts, e.g. air quality issues, noise etc. Furthermore, these trucks cause high impairment of the traffic flow in metropolitan areas because of the great number of their stops. The negative impacts, which have been referred to earlier, show the importance of policy intervention to improve the situation. Due to the goal conflict between the interests of the economy, the traffic participants and the residential population, acceptable solutions for increasing the efficiency of urban transport and logistics systems have to be developed Actually, finding measures, which are tailored to specific actors to alter their behaviour by changing their transport context, is the policy of demand management (Schroder et al. 2015; Taniguchi and Heijden 2000).

Our main research objective is to develop a conceptual framework to analyse smart policy options for identifying winners and losers of such measures, using multi-agent freight transport simulation. In a previous work, a conceptual proposal to model demand and supply in the CEP market as well as the mythology to model CEP demand and the modelling approach for parcel supply is presented (Schroder et al. 2015).

In this work, a more detailed view of our approach to characterise the demand and supply side of CEP service providers regarding e-commerce is given. Furthermore, a theoretical and empirical based approach to characterise them is presented and the first results of our study are presented in a typological order. The focus of our work with the main actors of our study is presented at first. Then, a classification regarding different aspects in this area is given. Further, the demand and the supply side and their identified parameters regarding e-commerce are considered separately. The demand side is subdivided into private households and businesses. As referred to before, the growing e-commerce demand of them generates a significant increase in trips of small and medium sized trucks in the CEP sector. The rising demand influences, among others, the traffic flow situation within the urban areas. Therefore, a theoretical and an empirical based approach are given. These help us to identify the parameters regarding demand and supply, which are crucial for a better understanding and modelling of CEP actors in the simulation.

2. Study Scope

We have the transport modeller's view and differentiate between market and geographical scope. In this paper, we describe the market scope and a theoretical and empirical approach for the consideration of the CEP demand and CEP supply. Furthermore, the most important parameters in each sector are presented in categories.

The following figure gives an overview of the actors and the field of our overall study perspective as well as of the focus of this paper. In figure 1, three different layers are visible. The first layer represents the CEP demand. This includes the sender and receiver relationships. The second layer is the CEP supply and includes the transport service providers and carriers, these are shown as delivering operator. The third layer represents the geographical aspects of the perspective. This includes the road network and is necessary for the implementation of the simulation model. In this paper, we focus on the first and the second layer. The study scope addresses the CEP transport, whereby our focus for the final simulation is on the business-to-consumer (B2C) and business-to-business (B2B) sector. The derived model will be applied to the last mile delivery of parcel and express transport in Berlin as an agglomeration in Germany.

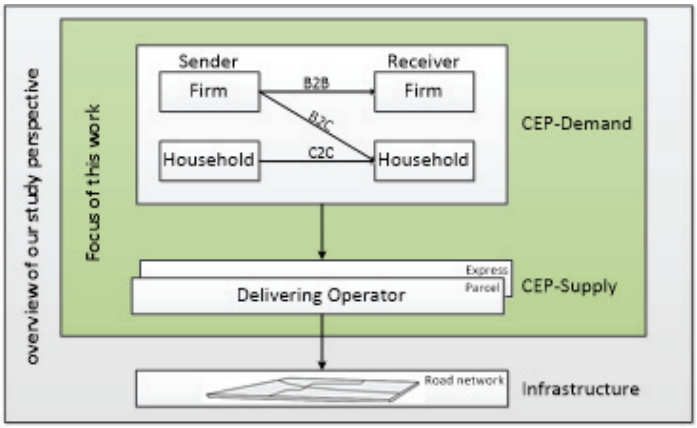

Fig. 1. Overview of the study perspective Based on (Schroder et al. 2015).

3. Methodology

To achieve the goals described above, the methodology was follows:

1. **Secondary data analysis**: literature, case studies and published texts and statistics have been examined and personal contacts have been utilised. We searched for parameters that influence CEP demand and CEP supply. These were collected and listed. These data are helpful in the research design and a subsequent primary research in the next step. Then, the collected parameters were categorised and accumulated in different clusters - according to their similarities. These results of the first step provide a baseline to identify the most important influencing parameters in CEP demand and CEP supply and identify the data gap from this point of view.
2. **Primary data collection and analysis**: there is some information, which is inaccessible because of secrecy of the companies. Furthermore, there is also information, which is in an aggregated level and is combined from several measurements, i.e. averages were formed from the individual values. A more specific example is the count of vehicles of each CEP service provider: in total, a number of 211,000 vehicles are used by CEP service providers using secondary data. Some of those vehicles drive more than 100,000 kilometres every year (Manner-Romberg et al. 2009).

   The fleet of a company as well as the type of vehicles available determine the possible number of deliveries and the capacities. Therefore, it is of importance to this research project to identify the fleet of each company. Each company gives their numbers in a different way. By this, Deutsche Post DHL states that they have a fleet of more than 89,000 vehicles of which 66% are transporters, trucks and passenger cars are each 17% (Deutsche Post AG 2013). UPS has a fleet of 8,800 vehicles in Europe whereas DPD has 9,000 vehicles in Germany (United Parcel Service of America 2015). In contrast to this, GLS gives the exact number of 4,896 vehicles in Germany (General Logistics Systems 2015). It shows the importance of a data collection to find the necessary information in a usable aggregation level for this study and for the simulation.

4. CEP-Demand

The transport demand of private households and firms influences the freight transport demand as well as the tours made by the CEP service providers. CEP intensity is understood as the demand of CEP service providers by private households and businesses. In the following paragraph the CEP intensity of these two is discussed and the parameters influencing the CEP intensity are identified by means of a secondary data analysis. With respect to the CEP intensity of businesses a survey needs to be conducted.

4.1. Private Households

As noted before, e-commerce is the biggest driver of the B2C sector. The scope of the studies used in this section is therefore on online shopping. As in previous studies (e.g. Farag et al. 2006a, Zhou and Wang 2014) we categorise the demand of private households into three different categories which are sociodemographic data, personal behaviour and spatial characteristics. These are further classified into quantitative and qualitative parameters for reasons of comparability and presented in table 1. In the following section we elaborate on some parameters which belong to one of these categories. These parameters will be evaluated in view of the multi-agent simulation in order to create an accurate snapshot of Berlin (long-term goal).

Table 1. parameters of private households
(Kille and Schwemmer 2015; Esser and Kurte 2014; BITKOM 2013; Cao 2009; Cao et al. 2012; Farag et al. 2007b; Farag et al. 2006a)

	Sociodemographic Data	**Personal Behaviour**	**Spatial Characteristics**
Quantitative	age	Internet frequency	level of urbanisation of place of residence
	gender	travel behaviour	accessibility of shops
	marital status		
	household size		
	income		
	education		
Qualitative		mobility behaviour	
		personal experience	
		lifestyle	
		shopping behaviour	

The sociodemographic factors include age, gender, marital status, household size, education and income (e.g. Farag et al. 2006a, Farag et al. 2006b, Farag et al. 2007b, Ren and Kwan 2009, Zhou and Wang 2014, BITKOM 2013, Krizek et al. 2005). The percentage of people doing online shopping among those using the Internet, is highest in the ages of 14 – 29 and 30 – 49 with 96% and 94% respectively (BITKOM 2013). These findings are supported by other studies where similar age ranges have been found (Farag et al. 2006a). Furthermore, the higher the education the more online shopping is being done (Zhou and Wang 2014; Clemes et al. 2014, Farag et al. 2006a). Opposing results have been found on the influence of the income on e-commerce: in one study, a negative impact of higher income on e-commerce has been found by whereas other studies indicate a positive effect (Zhou and Wang 2014, Krizek et al. 2005). Concerning the gender of a person different results have been found. The results of some studies indicate that males do more online shopping than females (Farag et al. 2006a, Farag et al. 2006b, Farag et al. 2007b). However, Ren and Kwan (2009) and Clemes et al. (2014) found that males do less online shopping than females. Therefore, the gender does seem to have some kind of influence on the e-commerce behaviour but the kind of the relationship cannot be identified at this stage. According to Zhou and Wang (2014) the household size influences the frequency of online shopping: bigger households tend to do less online shopping. Another study suggests that singles tend to do less online shopping (Farag et al. 2007b). With respect to the marital status Clemes et al. (2014) has found that singles tend to take up online shopping easier.

Personal behaviour includes the frequency of Internet use, the travel, shopping and mobility behaviour as well as personal experiences and life style (Zhou and Wang 2014, Farag et al. 2006a, Farag et al. 2006b, Farag et al. 2007b, Ren and Kwan 2009). The more active a person is on the Internet the more online shopping they tend to do (Zhou and Wang 2014; Farag et al. 2006b). Moreover, the more time people spend travelling during the day the more online shopping they do (Zhou and Wang 2014).

Spatial characteristics include the level of urbanisation of the place of residence and the accessibility of shops. Cao (2009) has reviewed the results of several studies with respect to two hypotheses: with the first one stating that residents in urban areas are more likely to do online shopping and the second one indicating that people who do not have a good accessibility of shops do more online shopping. Different results have been found: Some studies' results support the first hypothesis, some the second and some did not deliver definite results with respect to the frequency of online shopping or the adoption to e-ecommerce (Cao 2009).

4.2. Parameters of Businesses

It is essential to understand the demand side with respect to businesses in order to model the CEP service providers in a multi-agent simulation. Our procedure was as follows:

1. A secondary data analysis was conducted in order to evaluate the current state of the art. The process of this will be explained in the first paragraph of this section.
2. With the results of the German Classification of Economic Activities, Edition 2008 (Destatis 2008), the secondary literature analysis and expert interviews we identified four relevant economic branches which will be investigated during the primary data analysis.
3. Based on the results of the secondary data analysis presented in the previous sections and in view of the multi-agent simulation we are currently constructing a survey. The design will be explained in the second half of this section.

A study about the CEP intensity of firms and their characteristics was conducted in the German city of Cologne (Esser and Kurte 2014). Cologne has the highest sales volume in the retail sector in the state of North Rhine-Westphalia. Two different streets were picked out in order to analyse the usage of CEP service providers by different shops. The analysis of these two streets led to different results as both of these locations have different characteristics with one of them being the centre of a district in Cologne and the other one being a main shopping boulevard located downtown.

On one of the streets pharmacies, opticians, travel agencies, shops for shoe- and leather goods as well as shops for telecommunication make frequent use of CEP service providers whereas shops with gastronomy, groceries, drug stores, small booths, floristics and department stores make almost no use of CEP service providers. The focus of the stores on the other street is mainly on consumer goods with a representation of national and international labels like COS, H&M, Diesel and Replay. 75% of the stores make use of CEP service providers which is nearly three times as much as the stores on the other street (27%). Shops, located on the main shopping street, making frequent use of CEP service providers, are in the sectors of textile, shoes and bags, cosmetics and jewellery. It was found that the usage of CEP service providers by gastronomy and food retailing is nearly zero. Considering this and taking into account that the numbers of this study are believed to be applicable to other German cities it seems reasonable to assume that shops in the sector of gastronomy and food retailing in Berlin make almost no use of CEP service providers. However, Kille and Schwemmer (2015) have found that 37% of the demand of CEP services results from the food sector, 20% of the market demand results from small businesses, 10% from the service sector, 6% from the clothing sector, 5% from each the automobile and other businesses.

Considering the differences between the results by Esser and Kurte (2014) and Kille and Schwemmer (2015) the CEP demand of businesses in Germany and its categories cannot be characterised at the current state using secondary data analysis. Therefore, we need to design and conduct a survey which will provide us with the necessary data as a true picture (snapshot) of the city is needed in order to develop a multi-agent simulation. At the moment the final version of the questionnaire which will be send to businesses in the economic branches **retail industry**, **gastronomy**, **services** and **organisations and universities** is being developed. A first test version will be distributed to a number of businesses in January 2016. The four branches have been chosen on the basis of the German Classification of Economic Activities, Edition 2008 (destatis 2008). The decision has been made to conduct the survey only within four branches of the economy based on expert interviews. Hence, the majority of the CEP deliveries are believed to be made within these branches.

The survey is being developed in accordance to the findings presented in section 2.2 and with regard to the multi-agent simulation which will be carried out at a later point. As a first step we need to look at Berlin itself: it consists of 12 districts which are further divided into 96 quarters (Berlin.de 2015b). In 2014, the city had nearly 3.5 million

inhabitants and in 2013 the number of companies domiciled there reached almost 171.000. Of these, nearly 11.500 companies are in the retailing sector; nearly 11.000 in the gastronomy, around 58.500 offer services and 473 are organisations or universities (Statistik Berlin Brandenburg 2015). For the simulation it is of great importance to know the density per km2 of companies at the level of quarters. For each quarter, a range of the density per km^2 of companies there is available (Unternehmen und Betriebe in Berlin 2014). In combination with the size (in km^2) of each quarter (Statistik Berlin Brandenburg 2015)) we calculated and upper and a lower limit of the number of companies in each quarter. Following this, we used cluster analysis with the k-means algorithm to divide the quarters into different clusters with respect to the estimated number of companies (Xu and Wunsch 2009).

Considering policies there is an environmental zone in Berlin. It has a size of approximately 88 km^2 and includes the city centre (Berlin.de 2015a).

Based on this and section 2.2, the businesses will be asked to give some information regarding the company itself like questions on the number of employees, the size of the location site, the postal code and whether the company lies within the environmental zone as well as the economic branch and the total revenue. Furthermore, there will be questions on the usage of CEP service providers with regard to the sending and receiving of parcels. Information should be available on the frequency of receiving and sending of parcels during a typical week. These information need to be available on a daily basis for different time slots. Concerning the traffic flow within the city the parking site of the cars of the CEP service providers is relevant. Hence, this will be asked in the survey.

Data with respect to the CEP service providers is available. These include the locations of the transhipment hubs (network structure) and their total handling volume. The shipment volume as well as the kilometre performance by means of transport in Berlin will be estimated from the results of the survey.

5. CEP-supply

In this section we consider the CEP service providers at first. We examine their properties based on the delivered shipments. Then, we look at the last mile delivery. We present a theoretical approach to identify the influencing parameters in CEP service providers. The parameters are also represented.

5.1. Classifications

The focus of this section is on the classification of the three segments of the CEP service providers which are courier, express and parcel delivery. These can be classified by their sender-receiver relation, their weight and size, the type of accompaniment, the time and speed of the delivery process or by their route (Esser and Kurte 2014).

Often three different sender-receiver relations including business-to-business (B2B), business-to-consumer (B2C) and consumer-to-consumer (C2C) relations are considered. However, Schroder et al. (2015) note that back rates - consumer-to-business (C2B) - should be taken into account separately, which are especially high with certain types of products. In 2012, 48% of the parcels in Germany were send from businesses to consumers (B2C), 39% from businesses to other businesses (B2B), 6% were in the consumer-to-consumer (C2C) sector and 7% in the consumer-to-business (C2B) sector (Manner-Romberg et al. 2013). As described earlier, with the increasing use of the Internet, e-commerce has become available to a very large number of customers (Holdorf and Haasis 2014). Further growth of the B2C share is expected as the e-commerce sector continues to grow (Esser and Kurte 2014). Parcels in the standard segment are restricted in their **weight and size.** The typically allowed weight of a parcel is up to 31.5kg. In contrast, there are no restrictions upon the size and weight for courier and express deliveries. The **accompaniment** of the shipments during the delivery process differs between the three segments. Same day (courier) deliveries are permanently accompanied in person or by electronic means and express shipments are usually accompanied just by electronic means. Even, deliveries can be classified by the **time and speed** of the delivery process. Courier shipments are usually delivered on the same day. The transportation is carried out by one company with its own couriers from sender to recipient and as fast as possible. Delivery times which are agreed upon beforehand are characteristic in the express segment whereas parcels (standard term shipments) do not have a guaranteed delivery time. An important characteristic of courier shipments is that the **transportation** is generally performed on a direct route. The delivery is individual and not standardized. This means that they do not pass transshipment hubs. In comparison to this, both

express deliveries and parcels are transported via transshipment hubs (Manner-Romberg et al. 2013; Esser and Kurte 2014).

The characteristics described above are represented in figure 2.

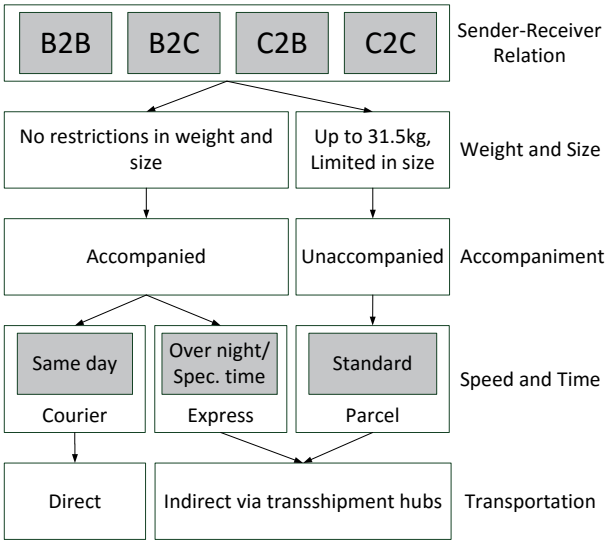

Fig. 2. Classifications of the CEP services based on different characteristics (Own presentation based on Esser and Kurte 2014; Manner-Romberg et al. 2013).

5.2. Parameters

In order to achieve the long-term goal of the study and to evaluate transport policies and logistical strategies regarding CEP service providers it is crucial to analyse and understand the most important parameters in the last mile delivery with respect to the traffic flow within cities and a sustainable delivery. In this section we introduce the parameters, which are identified and evaluate the most important ones using secondary data analysis. To find the most important influencing parameters, a detailed analysis of the literature and interviews with experts were carried out. Thereby, all parameters, which affect the traffic flow, are collected. The first step to analyse these collected parameters is to classify them. The parameters with the same properties were later classified in the same group. The parameters were categorised into **logistical master data**, **network structures**, **concept and strategies**, **performance data** as well as **others**. Further, these parameters have to be comparable. They have a different nature and not all of them are quantifiable. Therefore, they were further divided into **qualitative** and **quantitative** characteristics.

The identified parameters are presented in table 2. The number of employees, the total handling volume, the order structure, the shipment volume, the trade volume and the kilometre performance by means of transport are identified as the main parameters of the CEP service providers, which can affect the traffic flow situation in urban agglomerations. The choice of main parameters provides a hypothesis, which is based on expert interviews and our practical experiences in this segment. For a better understanding, the parameters should be explored with their relation to each other. For example, a large company with many employees usually has a higher revenue, larger shipment volumes and greater total handling volume than a company with fewer employees and fewer shipments and sales. Also the trip frequency will be correspondingly higher in larger companies which can be seen from the means of transport (unimodal, bimodal or trimodal transport). This can be set in relation with the network structure. Moreover, a company that uses many different means of transport could have a larger network than a company with only one transport mode and so on. According to Thaller et al. (2013a) there is a high correlation between the trip frequency and company size.

Table 2. Parameters of CEP Service providers in the last mile delivery based on expert interviews, own logistical interpretations and literature (Kille and Schwemmer 2015; Esser and Kurte 2014).

	logistical master data	network structures	concept and strategies	performance data	others
Qualitativ	portfolio	geographical location	market segmentation		market structure
		service territories	process		market potentials
		network structures	operation concepts		effects
		operation area of vehicles	development trends and strategies		
			order structure (courier, express, parcel)		
Quantitativ	**number of employees**	route data and cluster		**shipment volume**	market volumes
	max. handling capacity			**trade volume**	
	total handling volume			travel times	
	area information			distances	
	fleet			**kilometre performance by means of transport**	
				trip frequency	
				stop density	
				energy consumption (emissions)	
				average age of vehicle fleet	

According to the classification in qualitative and quantitative parameters, it is possible to compare the quantitative characteristics i.e., the number of employees, total handling, shipment and trade volume. Nevertheless, a quantification of these parameters is sought based on the simulation as our long-term goal. The parameters, their impacts as well as their relationships will be studied sequentially and presented in future works.

6. Conclusion and future directions

We presented first results of a theoretical and empirical based approach to characterise the supply side of CEP service providers as well as the demand side of private households and businesses with respect to e-commerce. In view of the multi-agent simulation which is to be developed in the course of this research project we conducted a secondary data analysis and are currently designing a survey in order to characterise the CEP demand of businesses.

In various studies, surveys were carried out to identify parameters which influence the behaviour of private households with respect to e-commerce (B2C). First, we have examined all known studies and analysed a wide variety of parameters and evaluated them with regard to the multi-agent simulation which will be carried out. Thereafter, we identified the most relevant parameters of CEP service providers (supply side) and presented them in a typological order. As previously mentioned, we have a transport modeler's view. Therefore, we have found - through a detailed secondary data analysis and the categorisation of the parameters - the following need of research in this field:

Fairly little literature is available on the CEP demand of businesses (B2B). Therefore, we are currently designing a survey in order to characterise the behaviour of businesses with respect to CEP. Questions arising here include the identification of CEP intensity of branches of the economy and their frequency of CEP use during a typical week. We believe that the results of this survey will be applicable to other cities in Germany.

Furthermore, due to the results of the secondary data analysis we believe that the e-commerce behaviour of private households could differ due to the different geographical and cultural backgrounds of the respondents, who live in different countries and social cultures. In accordance to this Zhou and Wang (2014) noted that "*shopping behaviour*

could vary substantially across different regions". The effects of the parameters are therefore not generally transferable to other countries.

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